

## CLAIMS:

1. A method of improving the thermal fatigue life of a thermal barrier coating by modifying the grain structure of an aluminide bond coat that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the steps of:

depositing the aluminide bond coat on the component so as to be characterized by substantially columnar grains that extend substantially through that portion of the bond coat overlying the surface of the component, the grains having grain boundaries exposed at the surface of the aluminide bond coat; and then

recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the thermal barrier coating on the surface of the aluminide bond coat, wherein new grains form at the surface of the aluminide bond coat.

2. A method according to claim 1, wherein recrystallization is induced by peening the aluminide bond coat at an intensity of at least 6A prior to heating the aluminide bond coat.

3. A method according to claim 1, wherein the aluminide bond coat is heated to a temperature of about 1090°C to about 1120°C.

4. A method according to claim 1, wherein the new grains have a grain size of not smaller than five micrometers after recrystallization.

5. A method according to claim 1, wherein the new grains are substantially equiaxed.

6. A method according to claim 5, wherein the

aluminide bond coat is a single-phase or two-phase aluminide.

7. A method according to claim 1, wherein precipitates are substantially absent from the grain boundaries.

8. A method according to claim 7, wherein the aluminide bond coat is a single-phase aluminide.

9. A method according to claim 1, wherein the aluminide bond coat is a diffusion aluminide bond coat.

10. A method according to claim 1, wherein the aluminide bond coat is an overlay aluminide bond coat.

11. A method of improving the thermal fatigue life of a thermal barrier coating by modifying the grain structure of an aluminide bond coat that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the steps of:

depositing the aluminide bond coat on the component by vapor phase aluminizing or by chemical vapor deposition, the aluminide bond coat comprising an additive layer on the surface of the component and a diffusion zone in a surface region of the component, the additive layer being characterized by columnar grains that extend from the diffusion zone to the surface of the aluminide bond coat, the grains having grain boundaries exposed at the surface of the aluminide bond coat;

peening the surface of the aluminide bond coat at an intensity of at least 6A; and then

heat treating the aluminide bond coat before or while depositing the thermal barrier coating on the surface of the aluminide bond coat so as to recrystallize at least a surface region of the aluminide bond coat,

wherein new grains form within the additive layer at the surface of the aluminide bond coat.

12. A method according to claim 11, wherein the aluminide bond coat is heat treated at a temperature of about 1090°C to about 1120°C.

13. A method according to claim 11, wherein the new grains have a grain size of not smaller than five micrometers after the thermal barrier coating has been deposited.

14. A method according to claim 11, wherein the new grains are substantially equiaxed.

15. A method according to claim 14, wherein the aluminide bond coat is a single-phase or two-phase aluminide.

16. A method according to claim 11, wherein precipitates are substantially absent from the grain boundaries.

17. A method according to claim 16, wherein the aluminide bond coat is a single-phase aluminide.

18. A method according to claim 11, wherein the aluminide bond coat is a diffusion aluminide bond coat.

19. A method according to claim 11, wherein the aluminide bond coat is an overlay aluminide bond coat.

20. A method of improving the thermal fatigue life of a thermal barrier coating by modifying the grain

structure of a diffusion aluminide bond coat that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the steps of:

depositing the diffusion aluminide bond coat on the component by vapor phase aluminizing or by chemical vapor deposition, the diffusion aluminide bond coat comprising an additive layer on the surface of the component and a diffusion zone in a surface region of the component, the additive layer being characterized by columnar grains that extend from the diffusion zone to the surface of the diffusion aluminide bond coat, the grains having grain boundaries exposed at the surface of the diffusion aluminide bond coat;

peening the diffusion aluminide coat bond coat at an intensity of 6A to 12A;

heat treating the diffusion aluminide coating at a temperature and for a duration sufficient to cause recrystallization of the entire additive layer of the diffusion aluminide bond coat, wherein equiaxial grains form within the additive layer; and then

depositing the thermal barrier coating on the diffusion aluminide bond coat;

wherein the new grains have a grain size of about fifteen to thirty micrometers.

21. An aluminide bond coat of a thermal barrier coating system on a surface of a superalloy component, the bond coat comprising an additive layer overlying the surface of the component and a diffusion zone in a surface region of the component, the additive layer having triangular grains at a surface of the bond coat and having substantially columnar grains in a portion thereof adjacent the surface region of the component.

22. An aluminide bond coat according to claim

21, wherein refractory precipitates are substantially absent from grain boundaries of the triangular grains.

23. An aluminide bond coat according to claim 21, wherein the bond coat is a single-phase aluminide.

24. An aluminide bond coat according to claim 21, wherein the bond coat is a two-phase aluminide.

25. An aluminide bond coat according to claim 21, wherein the bond coat is a diffusion aluminide bond coat.

26. An aluminide bond coat according to claim 21, wherein the bond coat is an overlay aluminide bond coat.

27. An aluminide bond coat according to claim 21, wherein the thermal barrier coating system comprises a ceramic layer overlying the bond coat, the ceramic layer having a columnar grain structure.

28. An aluminide bond coat of a thermal barrier coating system on a surface of a superalloy component, the bond coat comprising an additive layer overlying the surface of the component and a diffusion zone in a surface region of the component, the additive layer having equiaxial grains at at least a surface of the bond coat and having substantially columnar grains in a portion thereof adjacent the surface region of the component.

29. An aluminide bond coat according to claim 28, wherein the equiaxial grains have a grain size of not smaller than five micrometers.

30. An aluminide bond coat according to claim 28, wherein the bond coat is a single-phase or two-phase aluminide.

5 31. An aluminide bond coat according to claim 28, wherein refractory precipitates are substantially absent from the grain boundaries of the equiaxial grains.

10 32. An aluminide bond coat according to claim 28, wherein the bond coat is a diffusion aluminide bond coat.

15 33. An aluminide bond coat according to claim 28, wherein the bond coat is an overlay aluminide bond coat.

20 34. An aluminide bond coat according to claim 28, wherein the thermal barrier coating system comprises a ceramic layer overlying the bond coat, the ceramic layer having a columnar grain structure.

25 35. An aluminide bond coat of a thermal barrier coating system on a surface of a superalloy component, the bond coat comprising an additive layer overlying the surface of the component and a diffusion zone in a surface region of the component, the additive layer having grains that extend from a surface of the bond coat into the surface region of the component, the grains having grain boundaries that are substantially  
30 free of refractory phases.

36. An aluminide bond coat according to claim 35, wherein the bond coat is a single-phase aluminide.

35 37. An aluminide bond coat according to claim 35, wherein the bond coat is a diffusion aluminide bond

coat.

38. An aluminide bond coat according to claim  
35, wherein the bond coat is an overlay aluminide bond  
coat.

39. An aluminide bond coat according to claim  
35, wherein the thermal barrier coating system comprises  
a ceramic layer overlying the bond coat, the ceramic  
layer having a columnar grain structure.

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